
Space Weather Technical Forecast

Issued on Thursday, 26 January 2023 at 01:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Ongoing likelihood of R1/R2 Radio Blackouts day 1, but easing thereafter. Slight chance of G1/Minor Storms, mainly day 1 and day 3 (26th and 28th)

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with three M-flares observed. Peak flare was M4.6 at 25/1010 UTC from AR3190 Eki/Beta-Gamma-Delta, with two M-flares also observed from AR3192 Cai/Beta. Both of these sunspots are on the western limb, and will soon rotate off the Earth-facing disc. There are a total of nine numbered sunspots and two unnumbered regions, however beyond the two mentioned they are generally smaller and simpler. The main exception is AR3199 Dri/Beta-Delta, which despite its very small size does contain a rudimentary delta spot. Some ongoing flux emergence is also ongoing around AR3200 Cai/Beta, however this currently remains relatively simple. A CME was observed leaving the disc associated with the M4.6 flare, but is off the Earth-Sun line. No other CMEs were detected in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind was typical of relatively benign spaceweather conditions. Its speed, as measured by ACE/DSCOVR, was slightly elevated at between 400-500 km/s, with around average density. The total IMF, Bt, was mainly weak, but with a moderate peak of 9nT at 25/1755 UTC. The north-south component, Bz, was also generally weak, but peaked at moderate levels in both the southward and northward directions with an observable rotation from near -8nT at 25/1310 UTC, to near +9nT at 25/1755 UTC. The phi angle was mainly positive throughout, however (away from the Sun). Geomagnetic Activity was Quiet, with one Unsettled interval 25/1200-1500 UTC (Kp 0-3)

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 has been at Background levels throughout. High energy electron flux (greater than 2 MeV) has been at Background to Moderate. The associated 24-hour integrated electron fluence stayed well below the Active threshold, with 1.1e7 integrated pfu observed at 26/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate solar activity is likely to continue on day 1 (26th), before easing to mainly Low as current active regions on the west limb soon rotate off the Earth-facing disc. These regions will continue to give a risk of observed M-flares, with a slight chance of X-flares day 1 and perhaps day 2 (26-27th). All other regions are currently smaller and simpler, with only a slight chance of M-flares.

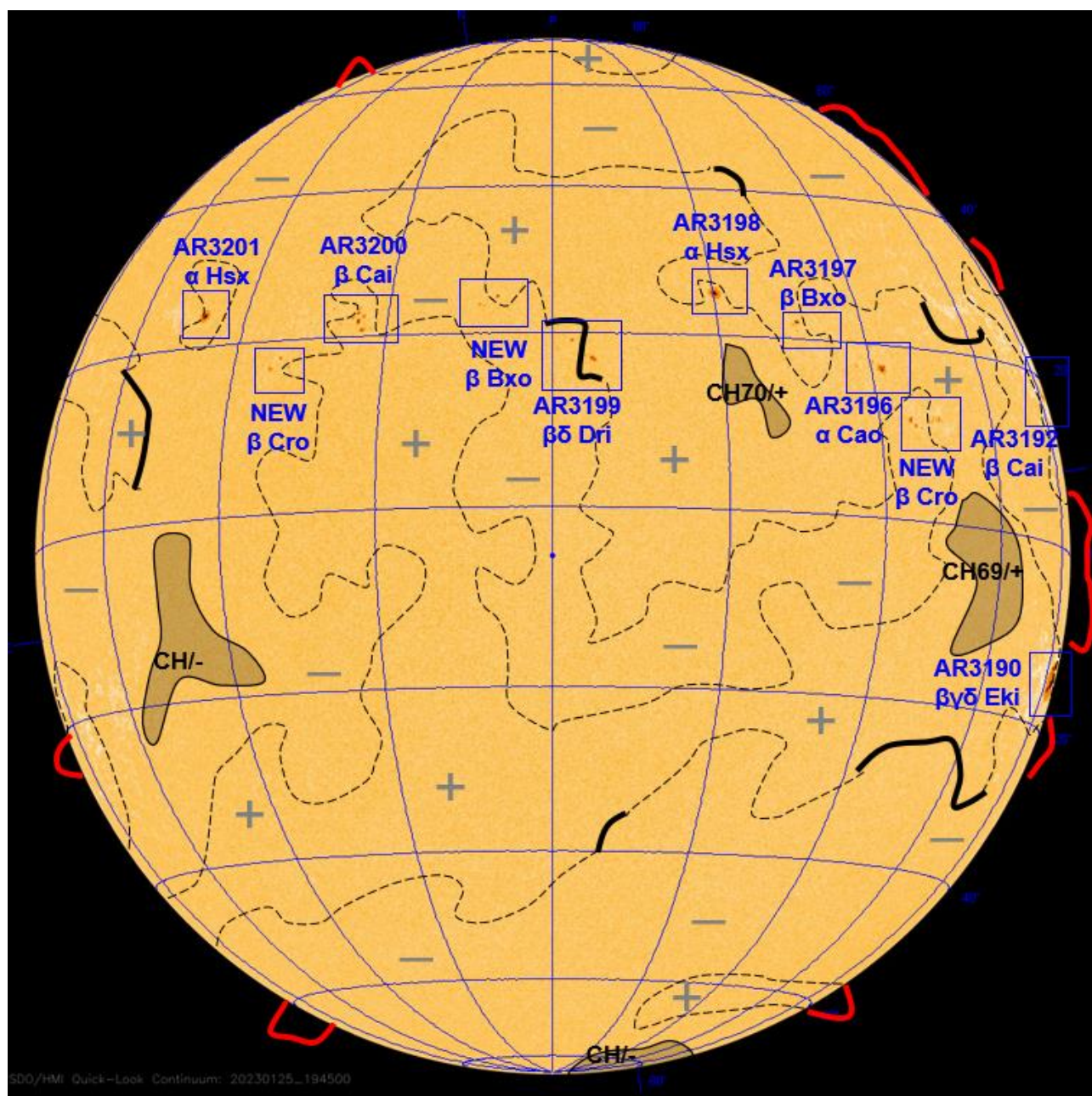
Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs in this forecast. Solar winds are expected to become elevated day 1 (26th) due to the arrival of the fast winds of CH69/+. A further transition into CH70/+ is then expected, most likely on day 3 (28th) bringing further elevated winds. Geomagnetic activity is expected to be Quiet with Unsettled spells for much of the period, but rising to Active with a slight chance of G1 Minor Storms. The greatest risk is on day 1 (26th) and day 3 (27th).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

observed by GOES16 is likely to remain at predominantly Background levels, but with a slight chance of reaching S1 or greater through the period. This risk is expected to ease day 3 (28th) onwards as AR3190 move further around the western limb. Electron flux is expected to be at Normal Background to Moderate levels at first, but likely rising later in the period response to any solar wind enhancements from the arrival of the fast winds of CH69 and CH70, This will bring a slight chance of Active fluence mainly day 3 (28th) onward.

Figure 1. Solar Analysis Valid 25/2000 UTC.



Key: Filament --- , Prominence --- , Magnetic Field Line --- , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson alpha-beta-gamma-delta and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

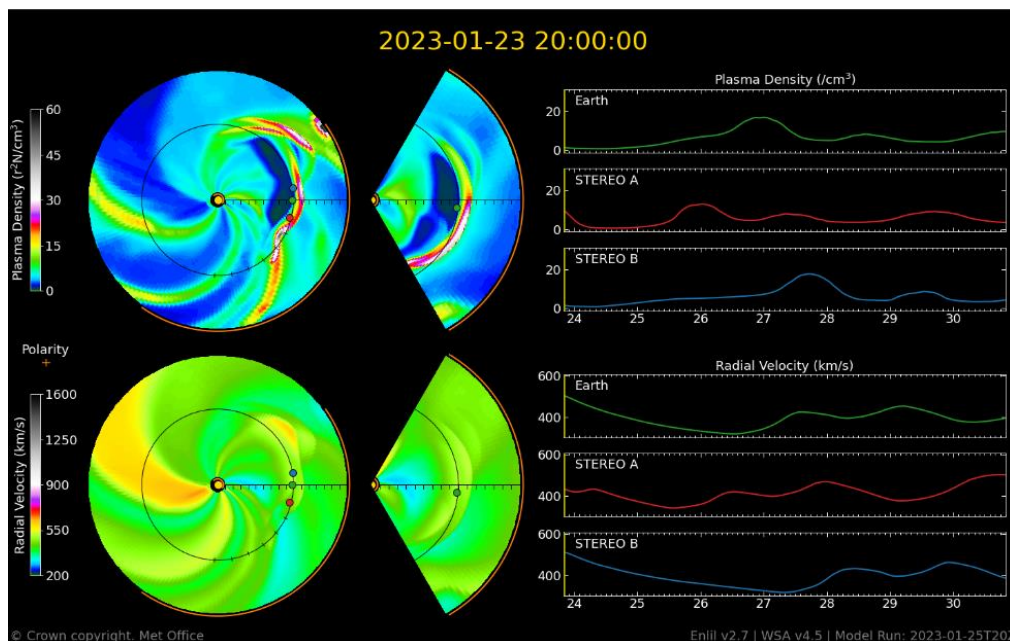
The forecast period currently features no Earth-directed CMEs.

Earth is due to see the arrival of the CIR of CH69/+ on day 1 (26th), before a transition into what is likely to be a modest high speed stream (HSS), potentially reaching around 500-550 km/s. This timing is good confidence with a clear enhancement observed in STEREO A around 1300 on 25th, with Earth subsequently seeing similar conditions around 1-day after. This is likely to be followed by a further similar enhancement day 3 (28th) due to CH70/+, as shown in MOSWOC enlil, although this is lower confidence

Geomagnetic activity is expected to be Quiet with Unsettled spells for much of the period, but rising to Active, with a slight chance of G1 Minor Storms, from the arrival of any coronal hole sourced fast winds, with the greatest risk on day 1 (26th) and day 3 (27th). However, with a period of slightly elevated to elevated winds expected, any passing transients will also bring a risk of Active spells throughout.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	10	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Enlil winds, showing enhancement later on the 26th into the 27th, and again on the 28th.



Radio Blackouts - X-Ray Flares:

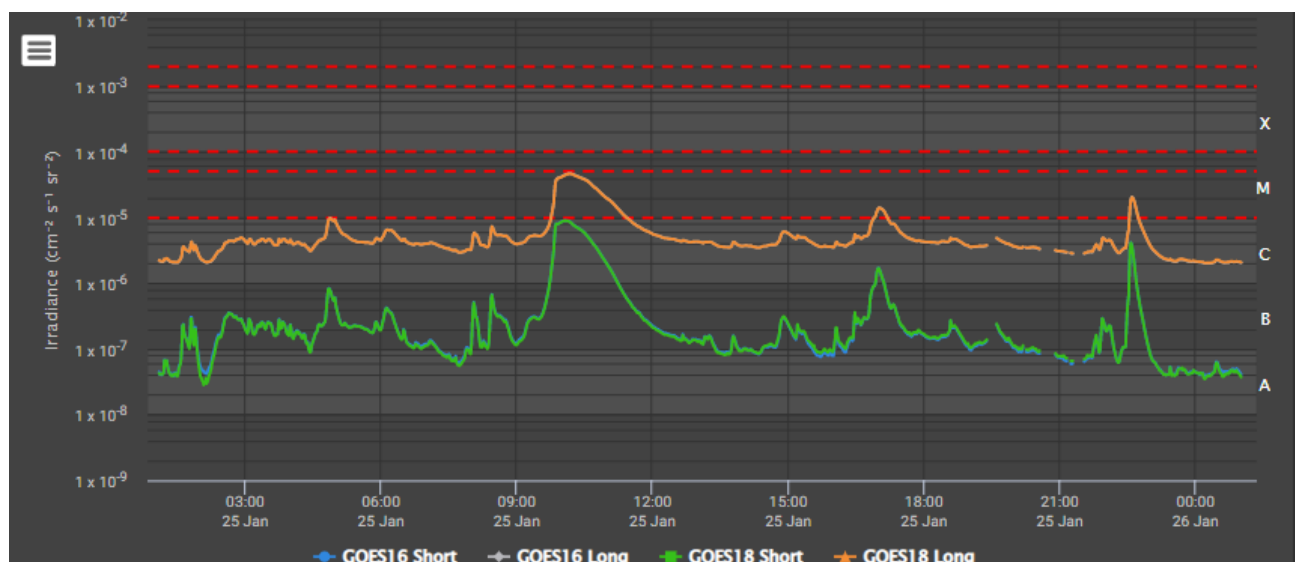
Recent Moderate activity levels are expected to fall through the period, as despite the large number of small sunspots on the disc, the main sources of this activity will soon rotating off of the Earth-facing side. The most recent M-flare activity has been from AR3190 and AR3192, however these are on the western limb, and will very soon rotate over the horizon.

There are a total of eleven active regions, nine of which are currently numbered, but besides the two previously mentioned, they are all small and generally simpler. The only potential exception at the moment is AR3199, which despite its very small size does exhibit a small, rudimentary delta spot. Besides AR3190 all these regions are in the northern hemisphere. Far-sided products are however indicative of further regions rotating onto the disc, with a bright area on STEREO-A euvi in the southwest, showing the likely return of ex-AR3181.

Overall, activity is likely to be Moderate with an ongoing chance of M-flares on day 1 (26th), and a slight chance of rising to High, before declining to be mainly Low by day 3 (28th).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	30	20	20
Very Active	R3 to R5 X Class	No	10	5	1	1

Figure 3: GOES-16/18 X-ray Flux



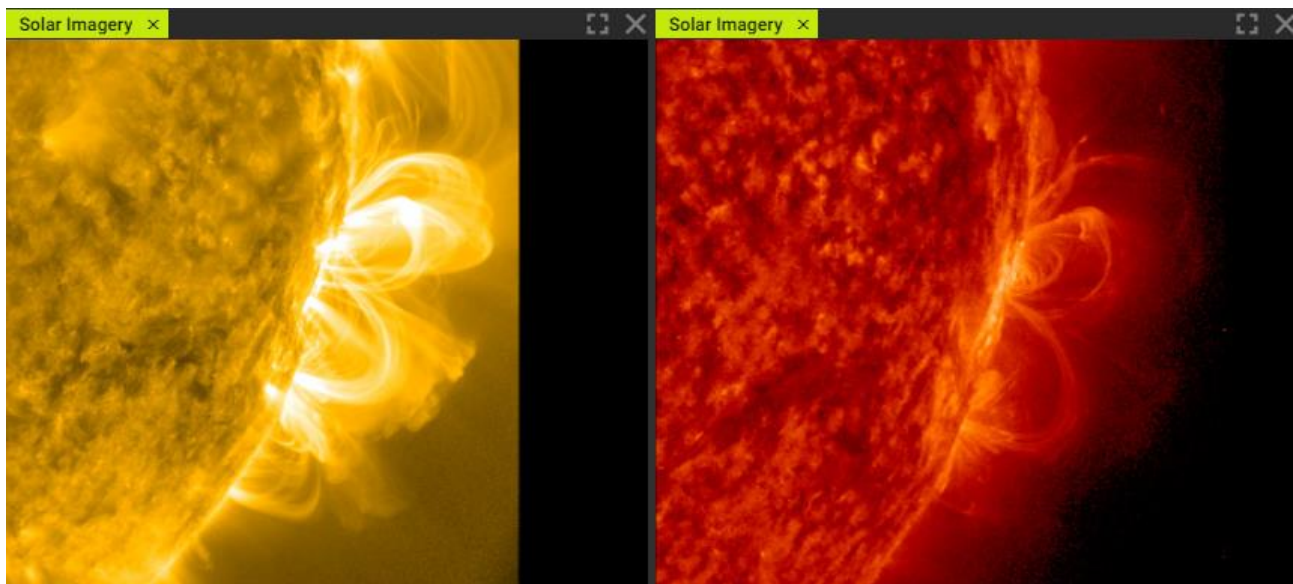
Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) protons as observed by GOES-16 are currently forecast to persist at background levels, but with a slight chance of rising in response to any significant flaring, and perhaps approaching the S1 level.

This is most likely to come from AR3190, which is now rotating over the western horizon and onto the far-side. Despite this, any notable flaring from this region will continue to bring a potential for increased proton flux, only gradually receding day 3 (28th) onward. Despite the large number of other active regions on the disc, these are all smaller and simpler, with a lower risk of proton rich flaring.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	10	10	5	5
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)						

Figure 4: SDO aia-217 (left) and SDO aia-304 showing magnetic looping on limb associated with AR3190, and the main risk of proton storms.



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2 MeV) is expected to persist at Background to Moderate levels at first, before likely dropping out for a time later day 1 (26th) as Earth moves into the fast wind from CH69. As the outer Van Allen Belt recovers to GEO, flux levels are likely to return to Moderate levels, with a chance of reaching High, mainly during peak periods of the diurnal cycle. This is low confidence however, with a chance of further suppression in values on day 3 due to the arrival of CH70 fast winds.

The associated 24 hour fluence is forecast to stay below the Active threshold throughout, but with a slight chance of rising above through the period. This is supported by REFM which indicated a general flat trend throughout, however this doesn't take account of the expected solar wind enhancement forecast for day 1 (26th), so is unreliable beyond this.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	10	20	20
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: GOES-16 $>2\text{MeV}$ Electron flux (top) and Fluence with REFM (bottom)

